

The fragile environment, ever growing tourism and the quest for sustainability: A case study from Duars, Alipurduar, West Bengal

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ABSTRACT

The Duars region of the northern part of West Bengal is picturesque with dense forests, hills, tea gardens, plantations and many rivers and streams. The Buxa Tiger Reserve (BTR), one of the many protected areas in the region, is one of the most biodiverse regions of the country. It boasts of many endemic plants and animals. It is the home for the endangered Indian Tiger. Besides this, the BTR is the source of income and livelihood of many local and ethnic populations residing in an around the reserve. The cultural and historical heritage of the BTR is also noteworthy. Therefore, the reserve is congenial for tourism and many eco-development activities have been planned and executed in the area. However, natural disasters, increasing human population, indiscriminate use of natural resources human wildlife conflict and growing pressure from anthropogenic activities has led to a loss of biodiversity, The reserve faces many management issues and challenges. The current study aims to do a thorough sectional analysis of the problems of biodiversity conservation and management in the BTR and suggest mitigation measures for the same.

Keywords: Buxa Tiger Reserve, Endemic plants and animals, Issues of Biodiversity, Ecotourism and Management.

Introduction

The West Bengal Duars (Duars), consisting of the floodplains and foothills of the Eastern Himalayas, is the gateway to the north-eastern parts of India and stretches from Siliguri in West to Buxa in the East and borders to Nepal, Bhutan, Sikkim and Bangladesh. It comprises of the plains of Darjeeling District, the whole of Jalpaiguri district and Alipurduar district and the upper region of Cooch Behar. Duars- the hunting grounds of the Rajas probably derived its name from the many Duars or doorways, like Buxaduar, Alipurduar etc which are dotted all over this region. Buxa Tiger Reserve (BTR) was set up as the 15th Tiger Reserve of the country at

the north-eastern corner of West Bengal bordering Bhutan and Assam in erstwhile Jalpaiguri district vide Government of India's notification no. J-M025/18/B/FRY (PT) dated 16/02/1983. It is currently located in the Alipurduar district between Latitudes 26°30'2" N to 26°50'2" N and Longitudes 89°25'2" E to 89°55'2" E extending about 50 km West to East and 35 km North to South. The reserve is formed by the entire forest area of the erstwhile Buxa Forest Division and some territory of the erstwhile neighbouring Cooch Behar Forest Division. The total area of the reserve is 760.87 km² of which 385.02 km² has been constituted as the Buxa Sanctuary and National Park and the rest 375.85 km² areas is considered as a buffer zone. Altitude varies from 125 m

(lowest point) to 1750 m (highest point) above mean sea level. The region is intercepted by many perennial and seasonal rivers namely Rydak, Sankosh, Jayanti, Bala, Dima, Kaljani, Panna, Gabur, Basra etc. Satellite view of BTR reveals the largest dense chunk of remaining forests in West Bengal. It is located at the confluence of three major bio-geographic zones: The lower Gangetic plains, Central Himalayas and the Brahmaputra valley (Das, 2012). Champion and Seth (1968) identified two major forest types: 1. Riverine Forest (Northern Dry Deciduous Seral Sal, Khair, Sisoo, Simul association and 2. Sal Forest (Eastern Bhabar and Terai Sal. Sal (*Shorea robusta*) is the keystone species and maintains the skeleton of the vegetation (Sarkar and Das, 2017). Buxa area is very similar in biodiversity to the Manas area and is actually close to the Manas National Park. In addition to supporting the endangered population of tigers (*Panthera tigris*), the BTR also serves an international corridor for elephant migration between India and Bhutan. There are 114 settlements [37 Forest villages within the reserve forest (buffer area), 8 forest villages within the core area, 44 revenue villages and 25 tea gardens] comprising of a large population of diverse ethnic compositions (Rava, Bhutia, Boro, Garo, Mech, Nepali, Santhal etc.) in and around BTR. (Sarkar and Das, 2012). In addition to the forest, the special attraction of BTR is the historical Buxa Fort that was used for detention during freedom movement of India as the

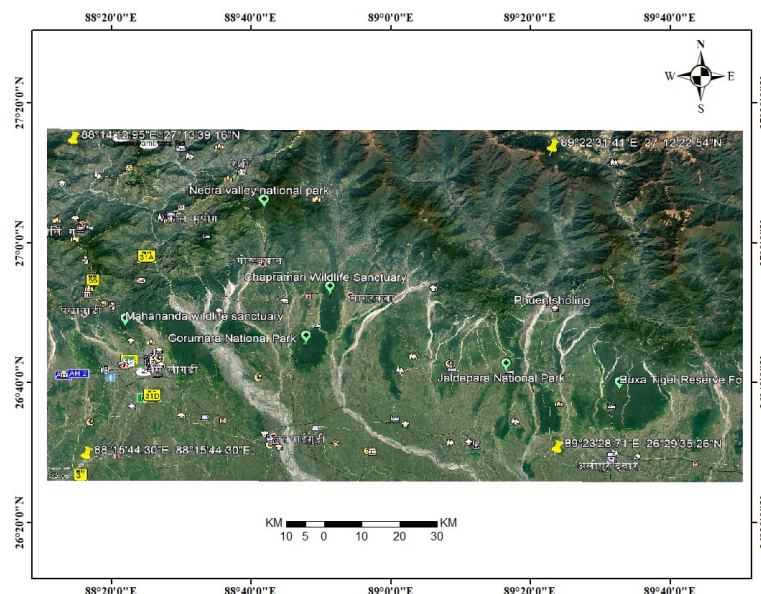
most rigorous prison next to Andaman cellular Jail. But unsystematic utilization of natural resources, unscientific application of bio sources and unskilled management profile and indiscriminate poaching together with unpredictable natural calamities demark as a terrible threat to forest chunk. Thorough segmental analysis is the required for the sustainable growth and the future (Geographic Information System) of tourism.

Case Presentation

BTR is home for the mystic and rich biodiversity. BTR boast of picturesque, landscapes, dense forests, myriad biodiversity, rich cultural heritage and enchanting historical background. The dolomite cave locally called the Mahakal also attracts numerous tourists and pilgrims with its beautiful stalactites and stalagmites. BTR attracts more than 20000 tourists and nature lovers every year. All these aspects make this place attractive for tourism. The Buxa Tiger Reserve has a lot of significant values in the current scenario at the global, national, state, regional and local level.

Assessment of Buxa Tiger Reserve

BTR represents the fragile Bhabar and Terai ecosystem. It supports at least ten distinct types of landscape elements namely 1) semi-evergreen vegetation forest, 2) dense evergreen forest, 3) deciduous forest, 4) dry thorn forest, 5) mixed vegetation and planta-



Map of the Study Area: Map of study sites through GIS (Geographic Information System)

tions, 6) degraded forests, 7) tea gardens, 8) teak plantations, 9) flood plains of the different rivers present in the reserve, 10) water bodies and 11) cultivation/settlements (Bhattacharya *et al.*, 2016). The Reserve acts as a carbon sink of the region. Reduction of soil erosion is one of its functions in addition to maintaining downstream erosion and sustenance of economic prosperity of the region (Das, 2012). BTR represents one of the most bio diverse forests in North East India. Ten types of forests are represented in the BTR namely Northern Dry Deciduous, Eastern Bhabar and Terai Sal, East Himalayan Moist Mixed Deciduous Forest, Sub-Himalayan Secondary Wet Mixed Forest, Eastern Sub-Montane Semi-evergreen Forest, Northern Tropical Evergreen Forest, Northern Tropical Evergreen Forest, Moist Sal Savannah, Low alluvium, Savannah Woodland (Directorate of Forests, Govt. of West Bengal). It provides shelter and protection and to many rare and threatened species of mammals, birds and reptiles included in the Red Data Book appendices of CITES e.g. Indian Tiger, Asiatic Elephant, Bengal florican, Hispid hare, Pangolin, and Monitor lizard etc. It also harbors many endemic species like marble cat, Chinese pangolin, clouded leopard, reticulated python etc. BTR is an international corridor of elephant migration between India and Bhutan (Roy and Sukumar, 2015). Local people get fodder, fuel wood, small timber, cane, thatch, edible mushroom, simul flower, medicinal plants and NWFPs (Non-wood Forest Products) like honey, dhuno, peacock feather etc. People of Jayanti village extract 35 species of plants of commercial importance to maintain their livelihood (Sarkar and Das, 2012).

Floral Biodiversity

More than 50 per cent of the plant species of India are represented in North-East India out of which 60 per cent are endemic (Das, 2012). More than 300 species of trees, 250 species of shrubs, 400 species of herbs, 9 species of canes, 10 species of bamboos, 150 species of orchids, 100 species of grasses and 130 species of aquatic flora including more than 70 sedges (Family: Cyperaceae) have been identified so far. There are more than 160 species of other monocotyledons and ferns (Directorate of Forests, Govt. of West Bengal). The main tree species is Sal (*Shorea robusta*). Sal (*Shorea robusta*) along with its associates viz. Champ (*Michelia champaca*), Simul (*Bombax ceiba*), Chikrasi (*Chukrasia tabularis*), Bahera (*Terminalia belerica*), Sidha (*Lagerstroemia parviflora*),

Chilaune (*Schima wallichii*), Lali (*Amoora wallichii*), Lasuni (*Aphanomixis polystachya*), Toon (*Toona ciliata*), occur in the plains. In the adjoining area of rivers Simul, Sisoo and Sirish are commonly found. Katus (*Castanopsis indica*), Bhalukath (*Talauma hodgsonii*), Phalame (*Walsura tabulata*), Mandane (*Artocarpus fraxinifolius*), associated with Gokul (*Ailanthus grandis*), Kimbu (*Morus laevigata*), Panisaj (*Terminalia microcarpa*) are found in the hilly areas. Savannah woodlands are characterised by Jamun (*Syzium cumini*), Tantari (*Dellenia pentagyna*), Kumbhi (*Careya arborea*) and Kul (*Zizyphus* sp.) The grasses mostly preferred by the wild herbivores are *Arundo donax*, *Themeda runderinacea*, *Imperata cylindrica*, *Phragmites karka*, *Paspalidium punctatum*, *Seteria glauca*, *Oryza* sp., *Thysanolanana* sp., *Saccharum* sp., *Andropogon* sp (Chaudhury, 2009; Bhattacharya *et al.*, 2016).

Faunal Biodiversity

In the Reserve 390 species of birds, 73 species of mammals, 76 species of snakes, 5 species of amphibians, 33 species of fishes and 500 species of insects (13 Orders, 65 Families and 229 Genera) have been identified so far. (Directorate of Forests, Govt. of West Bengal; Das 2012). The major carnivores of BTR are Indian Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Clouded Leopard (*Neofelis nebulosa*), Jungle Cat (*Felis chaus*), Leopard Cat (*Felis bengalensis*), Hog Badger (*Arctonyx collaris*), Sloth Bear (*Melursus ursinus*), Fishing Cat (*Felis viverrinus*), small Indian Civet Cat (*Viverricula indica*), Wolf (*Canis lupus*), Mongoose (*Herpestes edwardsii*), Bengal Fox (*Vulpes bengalensis*), Golden Jackal (*Canis aureus*), etc. The main herbivores of the reserve are Elephant (*Elephas maximus*), Gaur (*Bos gaurus*), Chital (*Axis axis*), Barking Deer (*Muntiacus muntjak*), Sambar (*Cervus unicolor*), Hog Deer (*Axis porcinus*), Wild Pig (*Sus scrofa cristatus*), Hispid Hare (*Caprolagus hispidus*), Black Giant Squirrel (*Ratufa bicolor*), Indian Giant Squirrel (*Ratufa indica*), and Pangolins (*Manis crassicaudata*, *M. pentadactylla*). BTR also has Endemic Indo-Malayan species such as Clouded Leopard, Chinese Pangolin, Reticulated Python (*Python reticulatus*), and Black necked Crane (*Grus nigricollis*) (Chaudhury, 2009). Among reptiles, various kinds of snakes such as King Cobra (*Ophiophagus hannah*), Russell's viper (*Daboia russelii*), Black Krait (*Bungarus niger*), Banded Krait (*Bungarus fasciatus*), Indian Python (*Python molurus*) and Reticulated Python (*Python reticulatus*), Chinese pangolin (*Manis*

pentadactyla) along with tortoises and lizards are reported in this region (Chaudhury, 2009). Sivakumar *et al.*, 2006 reported 284 species of birds from BTR. The important ones are Indian Jungle Maina (*Acridotheres fuscus*), Indian Magpie Robin (*Copsychus* sp.), Common Red Jungle Fowl (*Gallus* sp), Peafowl (*Pavo cristatus*), and Indian Pied Hornbill (*Buceros bicornis*). Pukhuri area in Phashkhawa block of BTR is the nestling site of the endangered Great Pied Hornbill (Fig 1.). The wetland of BTR also are the congregation spots of many migratory birds Whistling Teal (*Dendrocygna javanica*) as well as common Teal (*Anas crecca*), Pintail (*Anas acuta*), White Eyed Pochard (*Aythya nyroca*), Shoveller (*Spatula clypeata*) Ibis Bill (*Ibidorhyncha struthersii*), Minivets (*Pericrocotus* sp), Yellow Crested Sultan Tits (*Melanochlora sultanea*), Streaked Spider Hunter (*Arachnothera magna*) (Bhattacharya *et al.*, 2016). Sivakumar *et al.*, 2004 also reported 45 species of water birds in the reserve. Among the wetlands Narathali is vital as for migratory birds as it faced little anthropogenic disturbances and allochthonous inputs, like agricultural runoff or wastewater con-



Fig. 1. Pukhuri area in Phashkhawa block of BTR

tamination (Chatterjee *et al.*, 2017).

Varieties of fishes are present in the rivers and streams flowing inside the forest; most commonly found are Boroli (*Opsarius* sp), Puti (*Puntius* sp), Chital (*Chitala* sp), Boal (*Wallago attu*), Mrigel (*Cirrhinus mrigala*), Chela (*Salmostoma* sp), Kalbas (*Labeo calbasu*), Sole (*Cynoglossus* sp) etc. In a survey (2006) it has been found that Buxa Tiger Reserve has the highest number of fish species in the North Bengal region (Directorate of Forests, Govt. of West Bengal). Diverse species of butterflies are also found in the BTR. Commonly found species are Grass Yellow, Lemon Emigrant, Common Crow, Chocolate Albatross, Common Gull, Paris Peacock, Lesser Zebra, Common Bluebottle, Common Beak (Bhattacharya *et al.*, 2016). Indian Tiger (*Panthera tigris tigris*), Asian

Elephant (*Elephas maximus*), Regal Python (*Python regius*), Chinese Pangolin (*Manis pentadactyla*), Hispid Hare (*Caprolagus hispidus*), Hog Deer (*Axis porcinus*), Slender-billed Vulture (*Gyps tenuirostris*) etc are some of the endangered species found here. Genetically distinct tiger populations have been identified in BTR from mtDNA analysis (Sharma *et al.*, 2011). The number of tigers decreased from 70 in 2004 to 8-12 in 2008 (Mallick, 2010). A study in 2013 (Borthakur *et al.*, 2013) confirmed the presence of 15 individual tigers with 3 male, 9 female and 3 with unknown sex identity. However, no tigers were reported from BTR in the 2018 census (Jhala *et al.*, 2020). Rajabhatkhawa Vulture Breeding Centre at Buxa Tiger Reserve for the breeding and conservation of endangered Indian vultures was established with the help of Bombay Natural History Society and British charity Royal Society for the Protection of Birds. Elephants play a key role in the ecosystem acting as large dispersers of seeds of many forest trees. Though cattle have been found to attenuate the loss of elephants as seed dispersers (Sekhar *et al.*, 2015), the ecological function of elephants as large seed dispersers in this ecosystem is non redundant (Sekhar *et al.*, 2017). The faunal diversity may still be unexplored in the BTR. It is evidenced by the report of new animals every now and then. For example, two new species of frog have been discovered in the park in the year 2006 (Directorate of Forests, Govt. of West Bengal). Ghose *et al.*, 2019 gave the first photographic documentation of the Asiatic Golden Cat (*Catopuma temminckii*) from the reserve.

Issues of Biodiversity in BTR

A recent study has detected that 61% of area in Bengal Duars is configured to be vulnerable to climate change. The most vulnerable areas are the forested cover in Jalpaiguri, Baikunthapur, Wildlife-II, Wildlife-III, and Buxa Tiger Reserve East and their surrounding landscape. These areas have more climatic variation and are disrupted by anthropogenic and non-climatic activities access (Sam and Chakma, 2018). Devastating floods have been recorded in different rivers (Rydak, Bala, Dima, Gaburbasra) during 1950, 1952, 1954, 1968 and 1993 causing massive damage i.e., death of wild animals like deer, python etc and flora in BTR. Due to accumulation of flood water on forest floor, trees die off for “physiological drought”. The sand and the debris carried and deposited by the flood water on the forest floor reduces moisture holding capacity and soil resulting

in drying up and death of the forest standing crop. Floods cut off road connections and wash out wooden as well as concrete bridges. Due to recurrent flood, the river erosion has become menace to the reserve (Das, 2009; Das, 2012). Many local villages are also subjected to relocation because of the floods (Das, 2009). Wildlife habitat is destroyed by flood in the flood plains of river Sankosh, Rydak, Jainty, Bala, Dima and Basra during the monsoon. The courses of the streams and rivers are diverted with the consequent erosion of banks (Chaudhury, 2009). Climbers like *Bauhinia vahlii*, *Tinospora cordifolia*, *Smilax* sp, etc are a source of injury to trees and grass species of all ages. All the young plantations except teak are infested with prolific growth of weeds like *Lantana camara*, *Cassia tora*, *Solanum nigrum*, *Ageratum conyzoides*, *Leca* sp, *Clerodendrum* sp etc (Chaudhury, 2009). Different insects viz. defoliators, suckers, borers and fungi destroy the forest and plantation. Sal is also attacked by many borers like *Haplocerambyx spinicornis* and *Hipsiphia robusta*. *Polyporus shoreae* and *Formes caryophyllae* attack Sal root and bark respectively causing rot. Browsers like wild pigs and deer causes serious damage to young Sal, Gamar, Chikrasi plantations. Succulent simul roots are greatly liked by porcupines. Trampling on forest seedling by the elephants and gaur can't be recovered. A number of species have lost their habitat because of increased human activities. Sarkar *et al.*, 2018 have used faecal sample locations and GIS to examine the relationship between tiger presence and environmental features. Their study indicated that the niche for tigers is narrower than the available protected area. Only 62% of core protected area is suitable, of which only 17% is highly suitable for tigers (Sarkar *et al.*, 2018). Another study by Sarkar and Dutta, 2017 evaluated the forest cover change using Cellular Automata Markov Model. They have shown during the two decades between 1995 and 2015, large area of dense forest had been converted into plantation or open forest areas. Fragmentation levels increased by the past two decades. The predicted LULC (Land Use/Land Cover) map of the year 2035 shows the declining trend of dense forest area by 3.4% as well as the increase of the open forest or plantation by 1.07% respectively (Saha and Dutta, 2017). Habitat fragmentation has caused much harm to precious biodiversity of the region. It also increases the human wildlife conflict with large mammals like elephants, gaur etc. 13.56% elephant deaths are due to electrification while, 10.17% con-

tributes for train accidents. (Sah and Ahir, 2012). Many species have become threatened and extinct due to over exploitation by humans for their food, feed and other beneficial purposes. Tiger poaching, a lucrative business has been in rise and in commercial demand for 15 parts (like skin, bone, ears, whiskers, testes, penis, brain, eyeball, blood, bile, nail, heart, kidney, liver, pancreas etc.) in traditional Chinese medicines and other derivatives in China, South Korea, Kenya, Europe, Australia, North America, Japan, Taiwan and Singapore. Though hunting has been banned since 1970, Tiger, Leopards, Deer, Rhinoceros, Elephant, Wild Boar, Jungle Fowl and Sloth Bear etc were killed by indiscriminate shooting in the Buxa division (Datta and Bagchi, 2018). Water pollution occurs due to the discharge of untreated water, inorganic and organic waste and sewage by tourist hotel units. It decreases species diversity by decreasing dissolved oxygen in water and sediments. Air pollution from vehicle emissions, combustion of fuel do much more harm to mountain environments than to low lands due to less efficient combustion at high altitude on account of less oxygen. Noise pollution from tourist transportation and activities. Bhattacharya, 2016 reported the absence of proper waste management system in 28 mile forest village near Jayanti. Most of the hazardous wastes are either dumped or burned leading to environmental pollution. During the last century, agriculture has shifted from low input traditional systems involving crop rotations to highly commercialized monoculture practices that utilize high yielding varieties and use of harmful chemicals and fertilizers etc. Thirty four percent (34%) of the total plantation of BTR were converted to Teak and Jarul plantations (8578 ha) in different blocks like Rajabhatkhawa, Santrabari, Gudambari, Bhambari, Dima, Rydak, Bholka, Sankosh, Kumargram which is not congenial for wild animals. That is why carrying capacity of areas has decreased (Chaudhury, 2009). Illicit grazing of cattle by fringe villagers and tea garden laborers inside the Tiger reserve is a serious problem in Marakhata, Narathali, Rydak, Bholka, Poro, Nimati, Dalsingpara and Raimatang blocks as it reduces the availability of fodder to the wild herbivores and exposes them to the risk of Cattle Borne Diseases (CBD). It becomes acute during March-April (Chaudhury, 2009). About 150000 cattle graze the forest each day (Bhattacharya, 2016). Wild animals, particularly the herbivores, are very susceptible to diseases, most of which are transmit-

ted through domestic cattle. Various diseases like Anthrax, Rinderpest, Foot and Mouth disease and Tuberculosis are transmitted to the wild animals through domestic cattle (Chaudhury, 2009). Human wildlife conflict causes losses on both sides. The elephant is the most prominent species in conflicts at 92.3% causing human deaths, followed by leopards (4.3%) and gaur (3.4%) (Roy, 2017). Both human and elephant populations have increased in the last few decades. Forested areas have been converted into tea gardens, plantations, cultivable lands, roads etc. In North Bengal, the average annual number of human deaths and injuries to elephant attacks between 2006 to 2016 was estimated to be 212 (Naha *et al.*, 2019). The cases increase in maize or paddy cultivation harvesting season (Roy, 2017; Basu and Sah, 2012). Based on satellite imagery, it was found that area under agriculture had reduced by 128 km² with an annual rate of change of 2.5% whereas area under human settlements increased by 61 km² with an annual rate of change of 44%. (Naha *et al.*, 2019). Many wild animals are also killed due to collision with trains, vehicles and electrification. Eighty-nine (89) elephant deaths were reported from 61 accidents over a 41-year period in (1974–2015) along the 161-km long railway line between the Siliguri Junction and the Alipurduar Junction cutting through the forests of North Bengal including BTR (Roy, 2015). Proximity to elephant corridors, increase in

the number and speed of trains and lack of warning systems have been identified as key factors for elephant deaths due to train hits (Dasgupta and Ghosh, 2015). In some cases, the local people and tourists arrange for food provisions for monkeys (*Rhesus macaque*). Provisioning for the monkeys by local people and tourists has affected the seed dispersal of the wild trees in the BTR (Sengupta *et al.*, 2015). This region has a number of evergreen beauty spots like Rajabhatkhawa, Jayanti, Raimatang, Buxa hills, Jaigaon etc. There a number of safari and trekking routes (Fig 2.) that attracts a lot of tourists and hikers. A number of forest bungalows, hotels and home stays are located in the adjoining areas. Ecotourism provides livelihood to the local people along with conservation of the forest resources. However, Wildlife Institute of India (2013) assessed some of the negative impacts of tourism and eco-development.

Discussion

A number of recommendations are very much indispensable to manage the ecosystem of BTR. Afforestation programmes are imperative. However proper care should be taken in selecting the tree species for plantation so that ecological balance is least disturbed and biodiversity least reduced. For example, Sengupta *et al.*, 2016; 2018 recommended that affor-

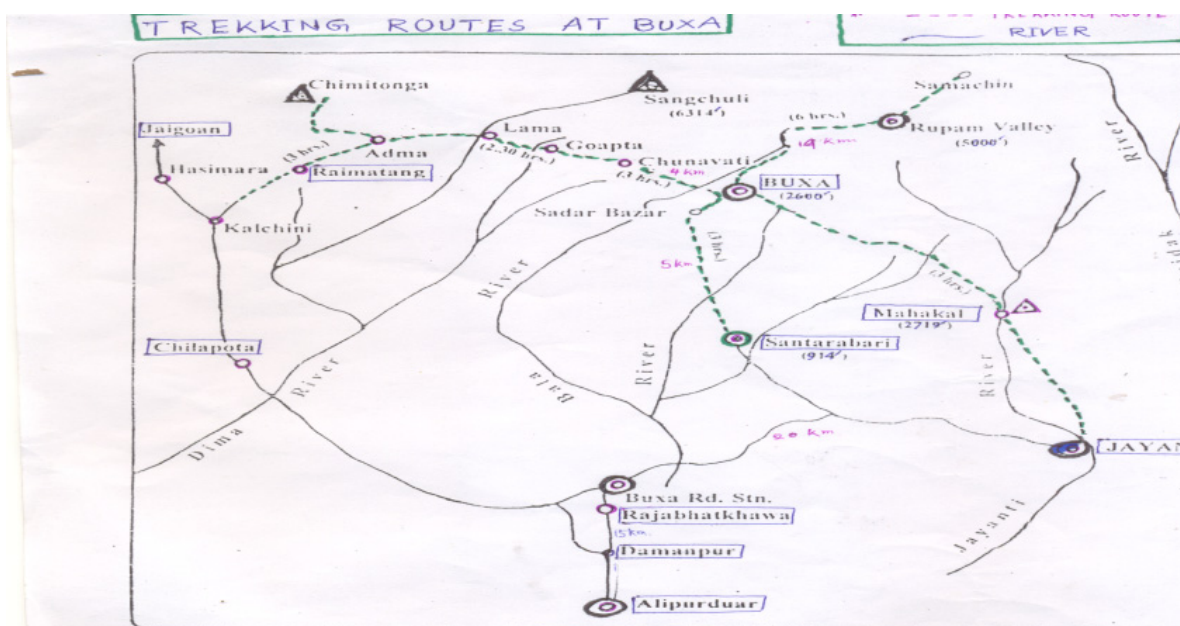


Fig. 2. Map of Trekking routes in BTR (Buxa Tiger Reserve), Alipurduar, West Bengal, India.

estation with preferred fruit species could reduce the movement of the Rhesus macaques towards the human settlements. Elephant corridors are fractured and narrowed due to anthropogenic activities. To restore the corridors, they can be converted into plantation forests (Roy, 2017). In addition, proper signal, limited speed and timings and remote tracking systems in the railway tracks can decrease the number of wildlife casualties due to train hits. Human Wildlife conflicts can be minimized by increasing the vegetation cover and providing sufficient food so that the animals do not gravitate towards human settlements. Detailed study of the land use and temporal patterns of crop raiders like elephants will help to devise proper management strategies to mitigate the conflict. Management measures should be taken to identify and manage water bodies to meet with the scarcity of water and also reduce human wildlife conflict (Datta, 2017). Rainwater harvesting is also a viable option in this region having heavy rainfall. One way to conserve the environment and wildlife is to reduce the pressure on the forest resources. Average number of households has increased tremendously as compared to number of households before 1970 (Das, 2005). Control of human population through birth controlling systems is required. Limited number of tourists should be permitted entry each year so that the ill effects of anthropogenic activities in the reserve can be reduced and it does not exceed the "tourism capacity" (Bhattacharya *et al.*, 2016) of the reserve is not exceeded. To decrease the pressure of illicit grazing, Das, (2008) suggested rotational grazing techniques. Practically it is not possible to remove cattle from the rural economy of the forest villages, where there is limited scope for alternative livelihood practices. Conservation cannot be achieved by marginalizing indigenous people. Many villagers of BTR have engaged in conflicts with the forest officials after relocation of their villages (Karlson, 1999; Kurian *et al.*, 2021). Failure to involve stakeholders in the conservation and management of forests and to give them alternative sources of earnings results in economic as well as ecological loss (Barman and Bhattacharya, 2005). Effective implementation of Joint Forest Management for the sustainable development of the reserve should be a priority. Policies should be framed and implemented in such a way so that the local people are not left out and do not come into conflict with the conservation authorities. Participation of the local people in the conservation activities should

be such that they are provided with adequate alternative income sources and are not forced to engage in illicit cutting of trees and hunting. The economic activities and livelihood of the forest villagers depend on agriculture, casual work, labor, which are not sufficient to fulfill their daily needs. Consequently, they involve in different type of illegal activities against forest environment (Datta, 2018; Debnath, 2016). The environmental crimes committed by the forest villagers have a positive correlation with the deprivation index (Datta and Bagchi, 2018). So if the needs of the people can be fulfilled by generation of alternative livelihood methods, it will lead to reduction in the environmental crimes. Local people should be made aware of the importance of the conservation of the forest as well as the laws governing the conservation. This is only possible through education of the local forest and fringe area dwellers. The Education Index ranges from 0.20 to 32 which is very low, indicates very weak education infrastructure in all the surveyed villages in BTR (Datta, 2018). Improvement of education and health facilities will lead to an overall socio-economic upliftment of the local people. Public awareness should also be created by organizing Nature camps for children, inclusion in academic curriculum, advertisements etc. Non-governmental organizations can also play key role in increasing both awareness of local people and the public in general and also influence community participation in conservation programs. Vehicles entering the reserve should be monitored regularly for their emissions and there should be a prescribed limit to the number of vehicles which would be permitted to ply through the forests. CNG (Compressed Natural Gas) driven vehicle may be constructive as it is less polluting and noisy. Water pollution should be checked by setting up treatment plants for waste water from the local settlements as well as tourism set ups. There should also be a proper waste management system in the settlements. To control noise pollution, laws should be strictly enforced so that the noise remains within the prescribed limits. State and Central Governments should be strict in the enforcement of laws pertaining to the conservation of wildlife and biodiversity.

Conclusion

Ecotourism developments in the Duars have both positive and negative environmental consequences.

It can safely be concluded that ecotourism cannot be regarded as an unqualified panacea for economic ills. In developing countries like India, owing to the need to generate income protected areas are more prone to damage caused by tourism. So, the challenge is to achieve the balance between demands of ecotourism/development and environmental conservation. Formulations of environmentally sustainable policies for the development of ecotourism in BTR of Duars are a precursor to the integration of eco-development and conservation. Sustainable development should be targeted towards increasing social-ecological resilience of local forest communities and alleviating pressure on biodiversity.

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Conflict of interest

The authors speak out that there is no clash of interest.

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